CLAIMS

What is claimed is:

1. A surface emitting semiconductor laser comprising:

(a) a semiconductor substrate, an epitaxial structure on the substrate including a layer with an active region at which light emission occurs, upper and lower cladding layers surrounding the active region layer, upper and lower faces, edge faces, one edge face having high reflectivity and one edge face having low reflectivity, and electrodes by which voltage can be applied across the epitaxial structure and the substrate; and

(b) a distributed feedback grating incorporated with the epitaxial structure comprising periodically alternating grating elements to provide optical feedback as a second order grating for a selected effective wavelength of light generation from the active region, the grating having a selected phase shift with respect to the high reflectivity edge face and positioned to act upon the light generated in the active region to produce lasing action and emission of light from at least one of the upper and lower faces of the semiconductor laser.

2. The semiconductor laser of Claim 1 wherein the grating is formed of alternating reflective elements and transmissive elements.

3. The semiconductor laser of Claim 2 wherein the reflective grating elements are formed of gold.

4. The semiconductor laser of Claim 3 wherein the gold elements in the grating are separated by air.

5. The semiconductor laser of Claim 1 including means for confining the current from the electrodes to a stripe region.

6. The semiconductor laser of Claim 1 wherein the electrodes are formed on the upper and lower faces of the semiconductor laser and the upper

electrode is formed on a cap layer to define an active stripe width in the active region layer at which light emission occurs.

7. The semiconductor laser of Claim 1 wherein the active region layer is formed of InGaAsP confinement layers and at least one InGaAs quantum well layer between the InGaAsP confinement layers, and the lower and upper cladding layers are formed of n-type InGaP and p-type InGaP, respectively, and the substrate is formed of GaAs.

8. The semiconductor laser of Claim 7 wherein the active region layer has multiple quantum wells defined by layers of InGaAs separated by InGaAsP confinement layers.

9. The semiconductor layer of Claim 7 including a cap layer of p-type GaAs over the upper cladding layer and wherein the grating is formed on the cap layer.

10. The semiconductor laser of Claim 1 wherein one edge face has a fully reflective coating thereon and the other edge face has an antireflective coating thereon.

11. The semiconductor laser of Claim 10 wherein the spacing between the highly reflective edge face and the adjacent metal grating element correspond to a grating phase shift value in the range of 10° to 80°.

12. The semiconductor laser of Claim 1 wherein one of the electrodes is formed on the lower face and has a window opening formed therein to permit light emission therethrough.

13. A surface emitting semiconductor laser comprising:

(a) a semiconductor substrate, an epitaxial structure on the substrate including a layer with an active region at which light emission occurs, upper and lower cladding layers surrounding the active region layer, upper and

lower faces, edge faces, and electrodes by which voltage can be applied across the epitaxial structure and the substrate; and

(b) a distributed feedback grating incorporated with the epitaxial structure comprising periodically alternating grating elements to provide optical feedback as a second order grating for a selected effective wavelength of light generation from the active region, the grating having a spacing between adjacent grating elements at a position intermediate the edge faces that corresponds to a selected phase shift in the grating, the grating formed and positioned to act upon the light generated in the active region to produce lasing action and emission of light from at least one of the upper and lower faces of the semiconductor laser.

14. The semiconductor laser of Claim 13 wherein the grating is formed of alternating reflective elements and transmissive elements.

15. The semiconductor laser of Claim 14 wherein the reflective grating elements are formed of gold.

16. The semiconductor laser of Claim 15 wherein the gold elements in the grating are separated by air.

17. The semiconductor laser of Claim 13, including means for confining the current from the electrodes to a stripe region.

18. The semiconductor laser of Claim 13, wherein the electrodes are formed on the upper and lower faces of the semiconductor laser and the upper electrode is formed on a cap layer to define an active stripe width in the active region layer at which light emission occurs.

19. The semiconductor laser of Claim 13 wherein the active region layer is formed of InGaAsP confinement layers and at least one InGaAs quantum well layer between the InGaAsP confinement layers, and the lower and upper cladding layers are formed of n-type InGaP and p-type InGaP, respectively, and the substrate is formed of GaAs.

20. The semiconductor laser of Claim 19 wherein the active region layer has multiple quantum wells defined by layers of InGaAs separated by InGaAsP confinement layers.

21. The semiconductor layer of Claim 19 including a cap layer of p-type GaAs over the upper cladding layer and wherein the grating is formed on the cap layer.

22. The semiconductor laser of Claim 13 wherein one edge face has a fully reflective coating thereon and the other edge face has an antireflective coating thereon.

23. The semiconductor laser of Claim 13 wherein the spacing between adjacent grating elements is in the middle of the grating.

24. The semiconductor laser of Claim 23 wherein the spacing in the grating corresponds to a grating phase shift of about 180°.

25. The semiconductor laser of Claim 13 wherein one of the electrodes is formed on the lower face and has a window opening formed therein to permit light emission therethrough.

26. The semiconductor laser of Claim 13 wherein the spacing in the grating corresponds to a grating phase shift of about 180°.

27. A surface emitting semiconductor laser comprising:

(a) a semiconductor substrate, an epitaxial structure on the substrate including a layer with an active region at which light emission occurs, upper and lower cladding layers surrounding the active region layer, upper and lower faces, edge faces, and electrodes by which voltage can be applied across the epitaxial structure and the substrate;

(b) a distributed feedback grating incorporated with the epitaxial structure comprising periodically alternating grating elements to provide optical feedback as a second order grating for a selected effective wavelength of light

generation from the active region, the grating having a spacing between adjacent grating elements at a position intermediate the edge faces that corresponds to a selected phase shift in the grating, the grating formed and positioned to act upon the light generated in the active region to produce lasing action and emission of light from at least one of the upper and lower faces of the semiconductor laser; and

(c) passive distributed Bragg reflector gratings incorporated with the epitaxial structure adjacent the distributed feedback grating to reflect light back to the distributed feedback grating.

28. The semiconductor laser of Claim 27 wherein the distributed feedback grating is formed of alternating reflective elements and transmissive elements.

29. The semiconductor laser of Claim 28 wherein the reflective grating elements are formed of gold.

30. The semiconductor laser of Claim 29 wherein the gold elements in the grating are separated by air.

31. The semiconductor laser of Claim 27 including means for confining the current from the electrodes to a stripe region.

32. The semiconductor laser of Claim 27 wherein the electrodes are formed on the upper and lower faces of the semiconductor laser and with the upper electrode is formed on a cap layer to define an active stripe width over the active region layer at which light emission occurs.

33. The semiconductor laser of Claim 32 wherein the active region layer is formed of InGaAsP confinement layers and at least one InGaAs quantum well layer between the InGaAsP confinement layers, and the lower and upper cladding layers are formed of n-type InGaP and p-type InGaP, respectively, and the substrate is formed of GaAs.

34. The semiconductor laser of Claim 32 wherein the active region layer has multiple quantum wells defined by layers of InGaAs separated by InGaAsP confinement layers.

35. The semiconductor layer of Claim 32 including a cap layer of P-type GaAs over the upper cladding layer and wherein the grating is formed into the cap layer.

36. The semiconductor laser of Claim 27 wherein both edge faces are formed to be antireflective.

37. The semiconductor laser of Claim 27 wherein the spacing is in the middle of the grating.

38. The semiconductor laser of Claim 37 wherein the spacing in the grating corresponds to a grating phase shift of about 180°.

39. The semiconductor laser of Claim 27 wherein the distributed Bragg reflector gratings are first order gratings.

40. The semiconductor laser of Claim 27 wherein the distributed Bragg reflector gratings are second order gratings.

41. The semiconductor laser of Claim 27 including an insulating layer over the distributed Bragg reflector gratings to inhibit current flow through these gratings.

42. The semiconductor laser of Claim 27 wherein one of the electrodes is formed on the lower face and has a window opening formed therein to permit light emission therethrough.

43. The semiconductor laser of Claim 27 wherein the spacing in the grating corresponds to a grating phase shift of about 180°.